Scientific Papers. Series B, Horticulture. Vol. LXVIII, No. 1, 2024
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE BEHAVIOR OF SOME DECORATIVE VARIETIES OF *IPOMOEA BATATAS* IN DIFFERENT CULTURE SYSTEMS AND TYPES OF SUBSTRATE

Alina-Ștefana OZARCHEVICI, Maria APOSTOL, Ciprian CHIRUȚĂ, Roberto Renato BERNARDIS, Lucia DRAGHIA

"Ion Ionescu de la Brad" Iasi University of Life Sciences, 3 Mihail Sadoveanu Alley, Iasi, Romania

Corresponding author email: lucia@uaiasi.ro

Abstract

The study was carried out on three ornamental varieties of Ipomoea batatas (`Heart Bronze`, `Black`, `Heart Lime`) grown in the field and in pots. Four types of substrate were used for pot culture: garden soil + peat, garden soil + peat + hydrogel, garden soil + peat + coconut fiber, garden soil + peat + coconut fiber + hydrogel. In field conditions, the plants from the three varieties were distinguished by a larger size than in the pots. Also, in the field, the higher degree of stem branching was recorded in `Black` and the longest branches in `Heart Lime`. The substrate garden soil + peat favored the length of the branches in all the varieties studied. The garden soil + peat + hydrogel at `Heart Lime` and the garden soil + peat + coconut fiber at `Heart Bronze` had a positive effect on the degree of branching. The use of two-factor ANOVA analysis indicates a strong influence of both the variety and the cultivation system on the morphological characters analyzed.

***Key words**: morphological characters, ornamental varieties, sweet potato.*

INTRODUCTION

The Sweet Potato (*Ipomoea batatas* (L.) Lam) belongs to the *Convolvulaceae* family, a large family with approximately 60 genera and over 1650 species (Escobar-Puentes et al., 2022). The genus *Ipomoea* comprises 600-800 species, with *I. batatas* taxonomically placed in the Batatas section, along with 13 other related wild species (Winslow, 2012; Jiang et al., 2022; Firon et al., 2009), namely *I. cordatotriloba*, *I. cynanchifolia*, *I. grandiflora*, *I. lacunosa*, *I. x leucantha*, *I. littoralis*, *I. ramosissima, I. umbraticola*, *I. tabascana*, *I. tenuissima*, *I. tiliacea*, *I. trifida*, *I. triloba* (Khoury et al., 2015; Nimmakayala et al., 2011). Currently, the origin of the sweet potato is widely accepted to be in Central and South America, specifically in the region between the Yucatan Peninsula, Mexico, and the Orinoco River in Venezuela (Austin, 1988, cited by Loebenstein, 2009). Determinations made using molecular markers support the hypothesis that Central America is the main center of origin of this species (Loebenstein, 2009). Some authors do not exclude the existence of secondary diversity centers, which could correspond to areas in China, Southeast Asia, New Guinea, and East Africa (Aguoru et al., 2015).

It appears that it was brought to Spain, and hence Europe, by Columbus, and spread to Africa, India, Southeast Asia, and the Philippines with the help of Portuguese explorers (Escobar-Puentes et al., 2022).

It is primarily cultivated in the tropical regions of Latin America, Africa, and Asia as a food crop (Xiong and Kaluwasha, 2022). Archaeological discoveries in Mexico and Peru indicate the cultivation of the sweet potato from 2500-2000 BC (Nimmakayala et al., 2011; Xiong and Kaluwasha, 2022; Aguoru et al., 2015).

I. batatas is considered a multi-purpose plant, having food, medicinal, and industrial importance (Behera et al., 2022). It occupies an important place in the category of high nutritional value food crops, due to its rich content of starch, proteins, β-carotene, vitamins (B_1, B_2, B_6, C, E), folic acid, essential minerals (Ca, Fe, Mg, Mn, Na, Cu, Zn) etc. (Aguoru et al., 2015; Baley, 2018; Sousa et al., 2019; Nimmakayala et al., 2011; Todesco et al., 2023; Andrade et al., 2017; Vînătoru, 2019). The tuberous roots are prepared in various ways (boiled, fried, baked) or can be turn into flour for the manufacture of bread and other bakery products. They also represent raw material in obtaining food colorants, industrial starch, liquid glucose, citric acid, monosodium glutamate, and alcohol. The leaves are used in animal feed (Behera et al., 2022; Dlamini et al., 2021; Escobar-Puentes et al., 2022; Rosero et al., 2019). The sweet potato also possesses numerous pharmaceutical properties, being used in the treatment of diseases such as diabetes, infections, anemia, hypertension, cancer, aging, allergies etc. (Behera et al., 2022; Escobar-Puentes et al., 2022; Jiang et al., 2022; Todesco et al., 2023).

The sweet potato prefers sunny locations, but also tolerates semi-shade, well-drained, sandy or sandy-loamy soils, and a pH of 5.5-6.5. It requires temperatures of 21-26°C and tolerates drought conditions relatively well, but struggles with excess moisture (Behera et al., 2022; Nedunchezhiyan et al., 2012). However, the sweet potato exhibits a very good adaptability to different environmental conditions, which has allowed its spread to temperate regions and altitudes that can reach 2000-3000 m (Behera et al., 2022; Nimmakayala et al., 2011), or in arid areas, on soils with low fertility, being considered one of the most important crops in ensuring food security in vulnerable areas (Todesco et al., 2023; Rosero, 2019; Glato et al., 2017). Recent studies also establish technologies in an unconventional system, in soilless cultures (Stoian et al., 2022).

I. batatas is a perennial plant, however, it is cultivated as an annual, especially in the temperate-continental climate (Behera et al., 2022; Nimmakayala et al., 2011). It presents tuberous roots with different shapes and sizes, depending on the variety, cultivation conditions, technology etc. The stems are long (1-7 m), cylindrical, usually twisted, green or purple, highly branched and easily form adventitious roots from the nodes upon contact with the soil. The leaves, arranged alternately, have petioles with dimensions of 2.5-20 cm, and the large blade, glabrous or slightly pubescent, oval, circular, triangular, cordate or hastate, entire or palmate-sectate (with 3-7 ovate to linear-lanceolate lobes) (Behera et al., 2022; Jiang et al., 2022; Vîlceanu, 1982; Vînătoru, 2019, Huaman, 1991). Some varieties may present variations in leaf shape within the same plant. The flowers are axillary, funnel-shaped, small in size, white or lavender-violet, with a darker center. The fruit is an ovoid or globular capsule, which opens in 2-4 valves (Buia et al., 1965; Behera et al., 2022).

The species is self-incompatible, and seeds are formed only when compatible varieties are cultivated for crossbreeding (Martin, 1965). Therefore, varieties of *I. batatas* are usually propagated vegetatively, by cuttings made from stems or from tuberous roots (Jiang et al., 2022; Behera et al., 2022).

Being a hexaploid species (2n = 6x = 90), *I. batatas* has a great variability of characters, especially in terms of the size, color and shape of leaves and stems, the size, shape, color and production of tuberous roots etc. (Rosero et al., 2019). Except green, leaves and stems have colors that vary from white to yellow, orange or brown-orange and from pink to red-violet or intense violet (Jiang et al., 2022). Therefore, through artificial or natural selections, a large number of varieties have been obtained, which differ both in morphology and in the chemical composition of the tuberous roots (Jiang et al., 2022).

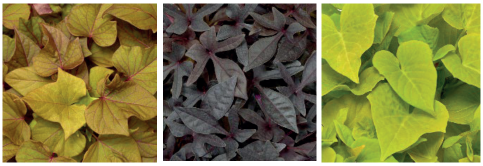
This explains the increasing interest in the ornamental use of some varieties of *I. batatas*, characterized by their beautiful foliage, persistent throughout the growing season and by the interesting aspect of the bushes, with a semi-erect or compact habit, trailing or climbing, with stems that can reach lengths of 3 m or more. Although they are usually used for their decorative foliage, some varieties are also capable of flowering (Huaman, 1991).

The sweet potato has a great ornamental potential (Sousa et al., 2018) if it is properly valued and offers a wide range of possibilities in the arrangement of gardens, terraces, and balconies. Its rapid growth is a major advantage in ensuring decor in a relatively short time, in hanging pots, flower pots, containers, and planters, or as a ground cover plant. It is a suitable choice for color spots, and the varieties with long stems for covering walls, pergolas, arches, etc. Recently, it is also found in the assortment of plants for arranging green walls (Cojocariu et al., 2024).

Despite all the advantages it offers, the culture of sweet potato is less widespread in Romania, for a long time being almost unknown as an ornamental plant, and as a food plant treated in the category of less widespread vegetables (Vîlceanu, 1982). However, in recent years, interest in this plant has increased, either for the production of tuberous roots (Vînătoru, 2019; Stoian et al., 2022), or for decorative purposes (Cojocariu et al., 2024; Ozarchevici et al., 2022). This paper aims to highlight a series of morpho-decorative characters of some ornamental varieties of *I. batatas*, under the conditions of their cultivation in the field and in pots, on different types of substrate.

MATERIALS AND METHODS

The plant material was represented by three varieties of *I. batatas*: 'Heart Bronze', 'Black', and 'Heart Lime'.



a) b) c)

Figure 1. a) 'Heart Bronze', b) 'Black', c) 'Heart Lime' (https://www.syngentaflowers.com/products/search/flower?keywords=sidekick&items_per_page=12)

'Heart Bronze' (Figure 1a) is a variety with a very high branching power, appreciated for its uniform habit and dense foliage, with a fine texture, in unique shades. At maturity, it can reach approximately 30 cm in height, with a branch length of 60-90 cm, even more under optimal conditions. The leaves are hastate, moderately lobed, with khaki green and ruby red or burgundy shades.

'Black' (Figure 1b) is characterized by its semi-erect habit, special foliage, and the ability to bloom throughout the growing season. The leaves, violet in color, are deeply lobed, thus giving the plant a "lacy" appearance. At maturity, the bush reaches up to approximately 30 cm in height, and the branches to lengths of 50-60 cm.

'Heart Lime' (Figure 1c) is a variety with long branches and a large covering capacity. At maturity, the plant can reach approximately 30 cm in height, with a branch length of 75-120 cm. The leaves are cordate or hastate, slightly lobed, lime green in color and ruby-red shades on the edge of the limb.

The composition of the substrates for pot culture was based on the combination of the following components: peat, coconut fiber, garden soil, and hydrogel.

SuliFlor peat (SF2) was used, with pH = 5.5-6.5 and medium structure (0-20 mm), improved with complex fertilizers (1.5 kg/m^3 NPK 14-16-18) and additives based on limestone and dolomite powder.

Dehydrated coconut fiber (Neopeat), supplied by Kertimag, was characterized by pH = 5.5-6.5 and water retention capacity of 650-850%.

The granulated hydrogel, an ecological water absorbent polymer based on potassium, supplied by Gardenis, presented a neutral pH and the density of the filtering surface of 30-60 mesh.

The garden soil was collected from the same area where the field crops were established.

The experimental cultures were established in 2023, in the experimental field of the Floriculture discipline, within the Iași University of Life Sciences, Romania (47°11′31″ N, 27°33′20″ E latitude, in temperate-continental climate with excessive nuances). For the establishment of the cultures, rooted cuttings were used, purchased from specialized companies (Syngenta Company).

In field conditions, the planting of the cuttings was done on ridges, at 80 cm between rows and 40 cm between plants in a row.

The pot culture was established in pots with a volume of 5 L and in different types of substrate.

The field experience was monofactorial, the experimental factor being represented by the variety, with three graduations, resulting in three experimental variants noted with the initials of the name: HB ('Heart Bronze'), B ('Black'), HL ('Heart Lime').

In the case of potted plants, the experience was bifactorial, one of the factors being the variety (with the three graduations and with the symbols presented earlier), and the other, the type of substrate resulting from the combination of the components symbolized by the initials of the name: GS (garden soil), P (peat), C (coconut fiber), H (hydrogel). The combinations made, respectively the variants, were the following: GSP (garden soil + peat), GSPH (garden soil + peat + hydrogel), GSPC (garden soil + peat + coconut fiber) and GSPCH (garden soil + peat + coconut fiber + hydrogel). In each variant of substrate, the components represented equal

parts in terms of volume, with the exception of the hydrogel, where the amount added to the mixture was 2 g/L.
The soil from the experimental field, namely the garden soil (GS) used in the mixtures for potted plants, is a cambic chernozem, with sandy-loamy texture and slightly alkaline pH (7.8). The mixtures that constituted the substrates of the potted cultures had a neutral to slightly alkaline pH (7.2-7.8). Regarding the content of main macronutrients, according to ICPA Bucharest (National Institute of Research - Development for Pedology, Agrochemistry and Environmental Protection), the level of total N (%), respectively P and K (mg/kg) falls within the good and very good level.
The experiments were organized in randomized blocks with three repetitions, with 9 plants/repetition.
Observations and determinations were made from the moment of setting up the experiments (May) until the end of the vegetation season (October). These were on biometric indices represented by the number of branches per plant and the length of the stems.
To establish the relationships between the analyzed characters, the scatter diagram of the values and mathematical modeling through linear regression and testing of the variant (ANOVA one-way) were used.
The association between a dependent variable and two independent variables was analyzed, using the ANOVA Two-Factor with Replication test which determines the influence of the first factor, the influence of the second factor, as well as the combined influence of the two factors. The statistical testing was performed with a significance level of 0.05, using the MS EXCEL professional application from the MS OFFICE 2019 package.

RESULTS AND DISCUSSIONS

The observations and determinations made aimed to evaluate the decorative effect of the three varieties of *I. batatas* cultivated either in the field or in pots, in different substrate compositions.
In Table 1, the absolute average values of the maximum length of the stems and the number of branches/plant are presented, recorded following the determinations made for all experimental variants from the field and pots. For all varieties, the plants grown in pots in GSP substrate formed the longest stems. The least favorable influence for this character was the GSPCH substrate. Cultivated in the field, the HB and B varieties recorded stem lengths with intermediate values between the maximum and minimum of those from pots, respectively 70.5 cm at HB and 52.5 cm at B. In contrast, the HL variety stands out with a stem length 2-3 times larger than the variants from pots (187 cm). This determined that the average length of the stems at the potted plants (65.7 cm) to be approx. 22% below the value of those in the field (84.5 cm).

Table 1. Stem length and number of branches (absolute values)

Cultivars	Growing system	Substrates	Stems length (cm)	Number of branches/plant (pc.)
HB	Pots	GSP	78.0	9.7
		GSPH	58.0	9.0
		GSPC	58.7	11.3
		GSPCH	51.7	10.3
	Field	-	70.5	6.0
B	Pots	GSP	72.7	5.0
		GSPH	51.7	6.0
		GSPC	61.3	5.3
		GSPCH	50.0	5.7
	Field	-	52.5	7.0
HL	Pots	GSP	86.7	8.3
		GSPH	80.3	10.0
		GSPC	76.0	8.3
		GSPCH	62.7	7.1
	Field	-	187.0	6.0
Average	*Pots*	-	*65.7*	*8.1*
	Field	-	*84.5*	*6.3*

The number of branches/plant had larger variations, depending on the variety, cultivation system, and substrate (Table 1). The GSPH substrate influenced the degree of branching of the stems at the potted plants of the B and HL varieties, while at HB the maximum values (11.3) were obtained in the GSPC substrate. Under field conditions, the degree of branching was below the value of the plants grown in pots for the HB and HL varieties, but larger at B. The average number of branches at the potted plants was larger than at the plants grown in the field (8.1, respectively 6.3).
In Tables 2-4, the relation between the stem length and the type of substrate used for potted cultures was analyzed for each variety. The analysis of variance (ANOVA) led to values smaller than the significance level of 0.05 and thus the hypothesis of equality of means was rejected. For this reason, the post-hoc Tukey

analysis was applied, which highlighted the data groups that differ as an average. The values for p-*values* obtained following the tests were centralized in Tables 2-8.

In the case of the HB variety, it can be observed that there are significant differences between all the resulting pairs, with the exception of the pair formed from GSPH and GSPC, where there is a similarity of 0.93.

Table 2. Relationship between the length of the stems and the type of substrate (`Heart Bronze`)

	HB GSPH	HB GSPC	HB GSPCH
HB GSP	0.00000*	0.00000*	0.00000*
HB GSPH		0.93070	0.00007*
HB GSPC			0.00001*

*Level of significance 0.05.

For the B variety (Table 3), as in the previous case, significant differences are observed between all pairs of substrate, this time with the exception of the pair formed from GSPH and GSPCH, with a value of 0.34.

Table 3. Relationship between the length of the stems and the type of substrate at (`Black`)

	B GSPH	B GSPC	B GSPCH
B GSP	0.00000*	0.00000*	0.00000*
B GSPH		0.00000*	0.34027
B GSPC			0.00000*

*Level of significance 0.05.

The HL variety behaves similarly to the HB variety, with significant differences for all pairs of substrate, with the exception of the pair formed from GSPH and GSPC, with a similarity of 0.66 (Table 4).

Table 4. Relationship between the length of the stems and the type of substrate (`Heart Lime`)

	HL GSPH	HL GSPC	HL GSPCH
HL GSP	0.00333*	0.00000*	0.00000*
HL GSPH		0.066340	0.00000*
HL GSPC			0.00000*

*Level of significance 0.05.

In a similar manner, the number of branches per plant was analyzed for each type of substrate, for each variety (Tables 5-7). For HB (Table 5), a similarity of approximately 0.21 was recorded for the substrate pairs formed from GSP with GSPH, respectively with GSPCH. The pair formed from GSPC and GSPCH recorded a similarity of approximately 0.67.

Table 5. Relationship between the number of the branches and the type of substrate (`Heart Bronze`)

	HB GSPH	HB GSPC	HB GSPCH
HB GSP	0.20917	0.01794*	0.20917
HB GSPH		0.00007*	0.00189*
HB GSPC			0.66632

*Level of significance 0.05.

In the case of the B variety (Table 6) however, the differences are significant only between the pair formed by GSPH and GSPCH.

Table 6. Relationship between the number of the branches and the type of substrate (`Black`)

	B GSPH	B GSPC	B GSPCH
B GSP	0.5501	0.35735	0.55000
B GSPH		0.75052	0.00189*
B GSPC			0.66632

*Level of significance 0.05.

The HL variety showed a behaviour similar to the HB variety, with the exception of the pair formed by GSPC and GSPCH, which had a similarity of approximately 0.75.

Table 7. Relationship between the number of the branches and the type of substrate (`Heart Lime`)

	HL GSPH	HL GSPC	HL GSPCH
HL GSP	0.20917	0.01794*	0.20917
HL GSPH		0.00007*	0.00000*
HL GSPC			0.75052

*Level of significance 0.05.

Through the Anova Single Factor analysis, the interaction between stem length and the number of branches per plant was also evaluated, depending on the variety and cultivation system (Table 8 and Table 9).

Table 8. Interaction between the length and number of branches according to the cultivar (in the pots)

	Stem length		No. of branches	
	B	HL	B	HL
HB	0.65086	0.17134	0.00000*	0.00206*
B		0.02129*		0.00000*

*Level of significance 0.05.

Table 9. Interaction between the length and number of branches according to the cultivar (in the field)

	Length of stems		Nr. of branches	
	B	HL	B	HL
HB	0.986992	0.81067	0.61624	0.00000*
B		0.72090		0.00000*

*Level of significance 0.05.

For plants grown in pots (Table 8), the length of the branches recorded significant differences only between the B and HL varieties, while the number of branches showed significant differences for all pairs of varieties formed (p-*value* < 0.05).

In the field crops (Table 9), the length of the branches between varieties shows a similar evolution for all pairs formed, reaching values of approximately 0.99 between the HB and B varieties. For the number of branches, were observed significant differences for all pairs of varieties, with the exception of the first pair formed from the HB and B varieties.

In order to reveal the effect of both substrate type and variety on the number of branches per plant, an ANOVA Two-Factor with Replication analysis was performed. Regarding the influence of the substrate type and the variety on the number of branches in potted plants (Figure 2), the p-*value* indicates significant differences (p-*value* < 0.05), as both the column interaction, which represents the substrate types, and the interaction between varieties influence the number of branches per plant.

SUMMARY	GSP	GSPH	GSPC	GSPCH	Total	
HB						
Average	9,66667	9	11	10,5556	10,055556	
Variance	0,25	0,8	1	0,52778	1,1968254	
B						
Average	5	5,9	5,55556	5,88889	5,5833333	
Variance	0	0,6	0,27778	1,11111	0,5928571	
HL						
Average	8,44444	10	8,44444	7,66667	8,6388889	
Variance	0,27778	0,8	0,27778	0,25	1,0944444	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	376,13	2	188,065	370,977	6,83E-46	3,091
Columns	6,85185	3	2,28395	4,50533	0,0053071	2,699
Interaction	45,4259	6	7,57099	14,9346	5,384E-12	2,195
Within	48,6667	96	0,50694			
Total	477,074	107				

Figure 2. Anova Two- Factor for the number of the branches according to the cultivar and the type of substrate (in the pots)

The analysis of stem length in potted plants indicates significant differences (0.0053) in the interaction between variety and substrate (Figure 3).

Also, using ANOVA Two-Factor with Replication analysis, it was determined the effect of the cultivation system and variety on the number of branches per plant and the length of the stems. For both characters analyzed, the p-*value* values indicate significant differences (Figure 4 and Figure 5), which indicates a strong influence of both the variety and the cultivation system on the analyzed morphological characters.

SUMMARY	GSP	GSPH	GSPC	GSPCH	Total	
HB						
Average	78	58	58,73333	51,7333	61,616667	
Variance	3,2025	10	10,1975	3,31	105,74543	
B						
Average	72,7	51,7	61,33333	50	58,933333	
Variance	4,34	5,76	4,6925	3,2075	88,304	
HL						
Average	86,7	80,3	76	62,7	76,433333	
Variance	15,56	18,5	10,625	6,0275	91,153714	
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	6395,81	2	3197,903	402,147	2,181E-47	3,091
Columns	8226,46	3	2742,152	344,834	2,948E-51	2,699
Interaction	992,253	6	165,3756	20,7965	1,759E-15	2,195
Within	763,4	96	7,952083			
Total	16377,9	107				

Figure 3. Anova Two-Factor for the length of the stems according to the cultivar and the type of substrate (in the pots)

SUMMARY	Field	Pots	Total			
HB						
Average	6	10,083	8,04			
Variance	0,1073	1,3561	5,05			
B						
Average	7	5,5	6,25			
Variance	0,0891	0,6364	0,93			
HL						
Average	6,05	8,5833	7,32			
Variance	0,0536	1,1742	2,26			
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	38,988	2	19,5	34,233	6,3E-11	2,748
Columns	52,361	1	52,4	91,95	4E-14	3,991
Interaction	99,688	2	49,8	87,531	2,7E-19	2,748
Within	37,583	66	0,57			
Total	228,62	71				

Figure 4. Anova Two- Factor for the number of the branches according to the cultivar and the growing system

SUMMARY	Field	Pots	Total			
HB						
Average	70,5	61,617	66,05833			
Variance	5,3291	106,85	74,23645			
B						
Average	52,5	58,933	55,71667			
Variance	2,8164	90,795	55,56754			
HL						
Average	188,08	76,433	132,2583			
Variance	31,174	86,604	3308,256			
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	82784	2	41392,07	767,543	2E-46	3,136
Columns	26038	1	26037,62	482,822	4,6E-32	3,986
Interaction	49479	2	24739,26	458,746	1,9E-39	3,136
Within	3559,2	66	53,92798			
Total	161860	71				

Figure 5. Anova Two-Factor for the length of stem according to the cultivar and the growing system

For the two characters analysed, similar studies in the literature on edible sweet potato varieties indicate approximately close values.

Regarding the number of branches, Shitikova (2022) reported 4 - 10 branches per plant in six sweet potato varieties, the number varying according to the variety used.

Gobena (2022), in a study on the adaptability of edible sweet potato varieties, reports branch length values between 56.3 and 143 cm. Similar values for edible varieties were also obtained by Shamil (2021) with length ranges between 135.2-175.1 cm and Nazrul (2018) with lengths of 119-192.3 cm, arguing that these differences may be due to both the genetic make-up of the genotypes and climatic conditions.

Another aspect analyzed was the tendency of variation in morphological characters (stem length and number of branches) depending on the type of substrate used in potted cultures (Figure 6).

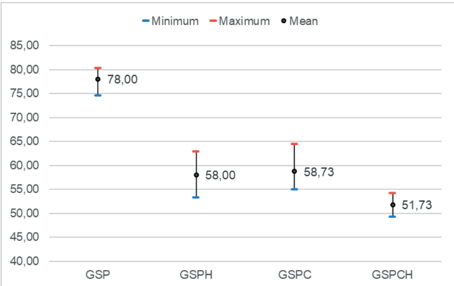


Figure 6. The minimum and maximum values for the lenght of stems according to the type of substrate (`Heart Bronze`)

For the HB variety, there is a tendency towards maximum values of stem length (78 cm) in the case of the GSP substrate, and a tendency towards minimum values (51 cm) in the case of the GSPCH mixture (Figure 6).

In the case of the number of branches per plant for the HB variety, the highest values (11) were recorded for the GSPC substrate. The minimum values (9) were for plants grown in the GSPH substrate (Figure 7).

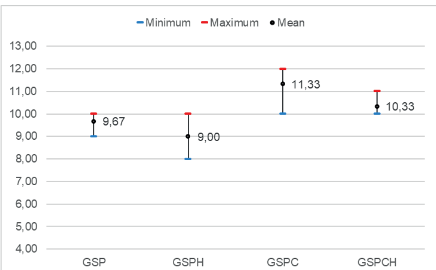


Figure 7. The minimum and maximum values for the number of branches/plant according to the type of substrate (`Heart Bronze`)

The trend towards maximum and minimum values of stem lengths for the B variety (Figure 8) is similar to that of HB, in the sense that the maximum values (72.7 cm) are in the GSP substrate, and the minimum ones (50 cm) are in the GSPCH substrate.

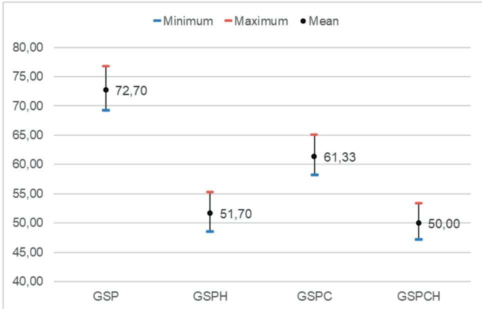


Figure 8. The minimum and maximum values for the lenght of stems according to the type of substrate (`Black`)

From the analysis of the number of branches in the B cultivar (Figure 9), a different reaction to the type of substrate was observed compared to the previous cultivar. Despite the fact that the disparities among the variants were not substantial, being between 5 and 6, the maxi-//mum values were determined by the GSPH substrate, and the minimum ones by the GSPC substrate.

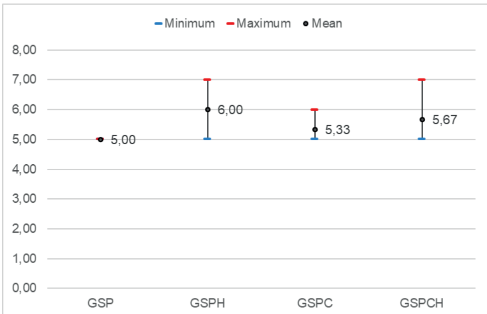


Figure 9. The minimum and maximum values for the number of branches/plant according to the type of substrate (`Black`)

With stem lengths ranging from 62.7-86.7 cm, the trend towards maximum values in HL was ensured by the GSP substrate, and the minimum values by the GSPCH substrate, somewhat similar to the other two cultivars, only with differences in the intermediate values from GSPH and GSPC (Figure 10).

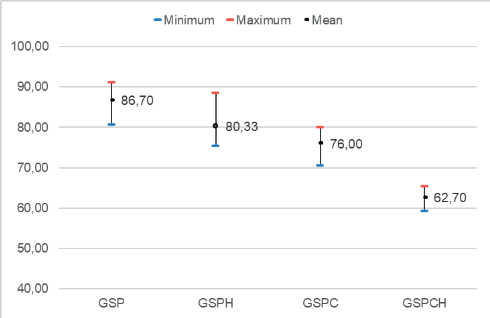


Figure 10. The minimum and maximum values for the lenght of stems according to the type of substrate (`Heart Lime`)

The degree of stem branching in the HL cultivar was higher in plants grown on the GSPH substrate, with an average of 10 branches per plant. On the GSPCH substrate, the values were minimal, with an average of 7.67 branches per plant (Figure 11).

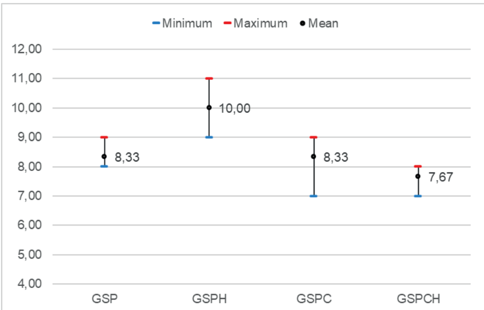


Figure 11. The minimum and maximum values for the number of branches/plant according to the type of substrate (`Heart Lime`)

The study also included the analysis of existing correlations between the morpho-decorative traits of *I. batatas* varieties and corresponding linear regressions were established. Pearson correlation coefficients were calculated and regression equations were written. In Figure 12, it is observed that between the stem length and the number of branches in the HB variety, the correlation is weak, but inverse (r = –0.22), the coefficient of determination being $R^2 = 0.0516$, such that the increase in stem length is weak correlated with the decrease in the number of branches.

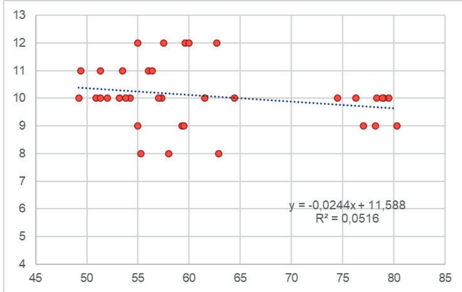


Figure 12. Correlation between length and number of the branches per plant (`Heart Bronze`)

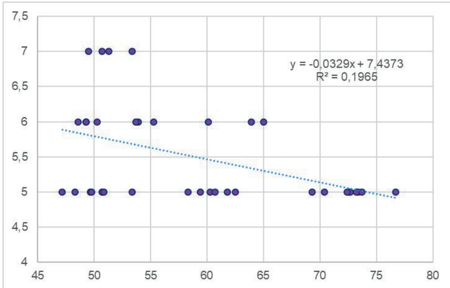


Figure 13. Correlation between length and number of the branches per plant (`Black`)

An average indirect correlation was observed between the analyzed traits in the B variety (Figure 13), with a correlation coefficient of r = –0.44. The determination coefficient is $R^2 = 0.1965$. This suggests a moderate negative relationship between the traits in this variety. The determination coefficient indicates that approximately 19.65% of the variation in one trait can be explained by the variation in the other trait.

The HL variety was the only one where the increase in stem length was associated with the increase in the degree of branching (Figure 14), the correlation coefficient being r = 0.36, show an average direct correlation and the determination coefficient being $R^2 = 0.1262$. This suggests a moderate positive relationship between stem length and degree of branching in this particular variety. The determination coefficient indicates that approximately 12.62% of the variation in the degree of branching can be explained by the variation in stem length.

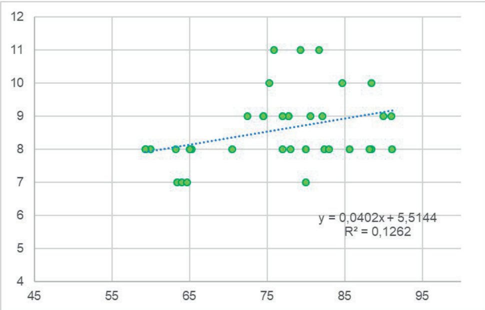


Figure 14. Correlation between length and number of the branches per plant (`Heart Lime`)

CONCLUSIONS

Regardless of the variety, the plants grown in pots in a substrate composed of garden soil and peat (GSP) formed the longest stems.

In field conditions, the 'Heart Lime' (HL) variety stands out through the stem length being 2-3 times larger than the pot variants (187 cm).

The substrate composed of garden soil, peat, and hydrogel (GSPH) favored the degree of stem branching in the plants grown in pots from 'Black' and 'Heart Lime', while in the 'Heart Bronze' variety the maximum values (11.3) were obtained in the GSPC substrate (garden soil, peat, and coconut fiber).

According to the results from the two analyzed characters, the presence of the hydrogel is only justified in combinations with garden soil and peat (GSPH) for the HL variety, and in combination with garden soil, peat, and coconut fiber (GSPCH) for the B variety, but only for better stem branching. It is not recommended for the HB variety.

Among the four substrates used for pot cultivation, the weakest results were recorded, in most cases, for the GSPCH variant.

Grown in the field, the 'Heart Bronze' and 'Heart Lime' (HL) varieties formed a smaller number of branches than those cultivated in pots, while 'Black' recorded higher values.

The correlation coefficients between stem length and the number of branches per plant indicate the presence of a direct correlation in 'Heart Lime' and an indirect correlation in 'Heart Bronze' and 'Black'.

The appropiate use for ornamental purposes of some *I. batatas* varieties studied will take into account both the genotypic characteristics (longer stems in HL, higher degree of branching in HB) and the culture system (longer stems in field for HL and for HB and B in pots; higher number of branches for B in the field and for HB and HL in pots).

ACKNOWLEDGEMENTS

This research work was carried out with the support of Doctoral School Studies at Iasi University of Life Sciences.

REFERENCES

Aguoru, C. U., Uhia, P., Olasan J. O. (2015). Varietal Characterisation and Taxonomic Evaluation of Sweet Potato (*Ipomoea batatas*) Using Macro- and Micromorphological Evidence. *Open Access Library Journal*, 2, https://www.researchgate.net/publication/282484054

Andrade, M. I., Ricardo, J., Naico, A., Alvaro, A., Makunde, G. S., Low, J., Ortiz, R., Grüneberg, W. J. (2017). Release of orange-fleshed sweetpotato (*Ipomoea batatas* [L.] Lam.) cultivars in Mozambique through an accelerated breeding scheme. *Journal of Agricultural Science*, 155, 919–929, https://doi.org/10.1017/S002185961600099X.

Behera, S., Chauhan, V. B. S., Pati, K., Bansode, V., Nedunchezhiyan, M., Verma, A. K., Monalisa, K., Naik, P. K., Naik, S. K. (2022). Biology and biotechnological aspect of sweet potato *(Ipomoea batatas* L.): a commercially important tuber crop. *Planta*, 256:40, https://link.springer.com/article/10.1007/s00425-022-03938-8.

Belay, Y. (2018). A review on sweet potato breeding for quality traits. *International Journal of Entomology and Nematology Research*, 2(1), 25-34.

Berhanu, T., Beniam, T. (2015). Performance Evaluation of Improved Sweet Potato (*Ipomoea batatas* L.) Varieties at Gedeo zone, southern Ethiopia. *Int. J. Sci. Res.* 6(14), 2319–7064. https://www.ijsr.net/archive/v4i9/SUB157572.pdf

Buia, A., Nyarady, A., Răvăruț, M. (1963). *Botanică agricolă, vol. II, sistematica plantelo*r. București, RO: Editura Agro-Silvică.

Cojocariu, M., Marta, A. E., Jităreanu, C. D., Chelariu, E. L., Căpșună, S., Cara, I. G., Amișculesei, P., Istrate, A. M. R.; Chiruță, C. (2024). A Study on the Development of Two Ornamental Varieties of *Ipomoea batatas* Cultivated in Vertical Systems in the Northeastern Region of Europe. *Horticulturae*, *10*, 133. https://doi.org/10.3390/horticulturae10020133

Dlamini, S. S., Mabuza, M. P., Dlamini, B. E. (2021). Effect of planting methods on growth and yield of sweet potato (*Ipomoea batatas* L.) varieties at Luyengo, midlevel of Eswatini. *World Journal of Advanced Research and Reviews*, 11(01), 013–021, https://doi.org/10.30574/wjaHB.2021.11.1.028.

Escobar-Puentes, A. A., Palomo, I., Rodríguez L., Fuentes, E, Villegas-Ochoa, M. A., González-Aguilar, G. A., Olivas-Aguirre, F. J., Wall-Medrano, A. (2022). Sweet Potato (*Ipomoea batatas* L.) Phenotypes: From

Agroindustry to Health Effects, *Foods*, 11(7), 1058. https://doi.org/10.3390/foods11071058.

Firon, N., LaBonte, D., Villordon, A., McGregor, C., Kfir, Y., Pressman, E. (2009). Botany and Physiology: Storage Root Formation and Development. *The Sweetpotato (Chapter 3)*, 13-26, Springer, https://link.springer.com/chapter/10.1007/978-1-4020-9475-0_3

Glato K., Aidam A., Kane N. A., Bassirou D., Couderc M., Zekraoui L., Scarcelli N., Barnaud A., Yves Vigouroux Y. (2017). Structure of sweet potato (*Ipomoea batatas*) diversity in West Africa covaries with a climatic gradient. PLoS ONE, 12(5), https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0177697.

Gobena, T.L., Asemie, M.M., Firisa, T.B. (2022). Evaluation of released sweet potato [*Ipomoea batatas* (L.) Lam] varieties for yield and yield-related attributes in Semen-Bench district of Bench-Sheko-Zone, South-Western Ethiopia. *Heliyon* 8, https://www.sciencedirect.com/science/article/pii/S2405844022022381?via%3Dihub

Human, Z. (1991). *Descriptors for sweet potato*. Rome, I: International Board for Plant Genetic Resources.

Jiang, T., Ye, S., Liao, W., Wu, M., He, J., Mateus, N., Oliveira, H. (2022). The botanical profile, phytochemistry, biological activities and protected-delivery systems for purple sweet potato (*Ipomoea batatas* (L.) Lam.): An up-to-date review. *Food Research International,* 161, (online, 111811), https://www.sciencedirect.com/science/article/pii/S0963996922008699.

Loebenstein, G. (2009). *Origin, Distribution and Economic Importance. The Sweet potato (Chapter 2)*, 9-12, Springer, https://link.springer.com/chapter/10.1007/978-1-4020-9475-0_2

Martin, F. W. (1965). Incompatibility in the Sweet Potato. A Review. *Economic Botany*, *19*(4), 406–415. http://www.jstor.org/stable/4252651

MCDonald, J. A., Austin, D. F. (1990). Chachanges and additions in *Ipomoea* section *Batatas* (Convolvulaceae). *Brittonia,* 42 (6), 116-120.

Nedunchezhiyan, M., Byju, G., Jata, S. K. (2012). Sweet Potato Agronomy. *Fruit, Vegetable and Cereal Science and Biotechnology*, 6 (1), https://www.researchgate.net/publication/285868564

Nimmakayala, P., Vajja, G., Reddy, U. R. (2011). *Ipomoea*, in *Wild Crop-Relatives: Genomic and Breeding Resources. Industrial Crops*, Chapter 7, 123-132, https://link.springer.com/chapter/10.1007/978-3-642-21102-7_7

Ozarchevici, A. S., Apostol, M., Chelariu, E. L., Draghia, L. (2022). Partial results regarding the behaviour of some ornamental varieties of *Ipomoea batatas* cultivated within the ecological conditions of Iași. *Lucrări științifice, seria Horticultură, USV Iași*, 65 (2), 115-120.

Prabawardani, S. (2007). *Physiological and growth responses of selected sweet potato* (*Ipomoea batatas* (L.) Lam.) *cultivars to water stress*. PhD Thesis. Townsville, AU: James Cook University.

Rosero A., Granda L., Pérez J. L., Rosero D., Burgos-Paz W., Martınez R., Morelo J., Pastrana I., Esteban Burbano E., Morales A. (2019). Morphometric and colourimetric tools to dissect morphological diversity: an application in sweet potato [*Ipomoea batatas* (L.) Lam.]. *Genetic Resources and Crop Evolution*, 66, 1257–1278, https://doi.org/10.1007/s10722-019-00781-x.

Shamil, A.S. (2021). Evaluation of sweet potato *(Ipomoea batatas* (L) Lam) varieties at tepi,southwestern Ethiopia. *World J. Agric. Soil Sci.* 6(4), 14. https://irispublishers.com/wjass/pdf/WJASS.MS.ID.000643.pdf

Shitikova, A.V. and Povarnitsyna, A.V. (2022). Productivity of sweet potato (*Ipomoea batatas* L.) in the conditions of the RF CRNZ. *IOP Conf. Ser.: Earth Environ. Sci. 1043,* https://iopscience.iop.org/article/10.1088/1755-1315/1043/1/012003

Sousa, R. M. D.; Peixoto, J. R., Amaro, G. R., Vilela M. S., Carmona, P. A. O., Carmona, R., Thomé, K. M. (2019). Morphoagronomic characterization of sweet potato accessions from the Germplasm Bank of Embrapa Hortaliças. *Bioscience Journal,* 35(6), 1708-1717, http://dx.doi.org/10.14393/BJ-v35n6a2019-42434.

Sousa, R. M. D.; Peixoto, J. R., Amaro, G. R., Vilela M. S., Costa A. P., Nobrega, D. S. (2018). Ornamental potential of sweet potato accessions. *Bioscience Journal,* 34 (supplement 1), 11-16, https://www.researchgate.net/publication/329453833_Ornamental_potential_of_sweet_potato_accessions

Stoian, M., Doltu, M., Drăghici E. M. (2022). The influence of the type of substrate on the production of sweet potatoes. *Journal of Horticulture, Forestry and Biotechnology*, 26(1), 46-50.

Tedesco, D., Moreira, B. R. A., Barbosa, M. R. Jr., Maeda, M., da Silva, R. P. (2023). Sustainable management of sweet potatoes: A review on practices, strategies, and opportunities in nutrition-sensitive agriculture, energy security, and quality of life. *Agricultural Systems*, 210, 103693.https://www.sciencedirect.com/science/article/pii/S0308521X23000987.

Vînătoru, C., Mușat, B., Bratu, C. (2019). *Tratat de legumicultură special.* Buzău, RO: Editura ALPHA MDN.

Vîlceanu, G. (1982). *Cultura legumelor mai puțin răspândite*. București, RO: Editura Ceres.

Xiong, X., Kaluwasha, W. (2022). Sweet Potato (*Ipomoea batatas*) Biology and Importance in U.S. *Agriculture,* 26 (5),https://juniperpublishers.com/artoaj/ARTOAJ.MS.ID.556346.php

Winslow, B. K. (2012). *Interspecific Hybridization and Characterization of Variegation in Ornamental Sweet potato* (*Ipomoea batatas* (L.) Lam.). Master Thesis. Raleigh, North Carolina, USA: North Carolina State University.

https://icpa.ro/documente/coduri/Evaluarea_continutului_de_nutrienti_din_sol.pdf - ICPA București, Evaluarea conţinutului de nutrienţi din sol (cap. 6.1).